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(54) **ENERGY ABSORBER FOR A VEHICLE SEAT, LINEAR ADJUSTER FOR A VEHICLE SEAT HAVING AN ENERGY ABSORBER, AND VEHICLE SEAT**

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§ 371 (c)(1),

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(57) **ABSTRACT**

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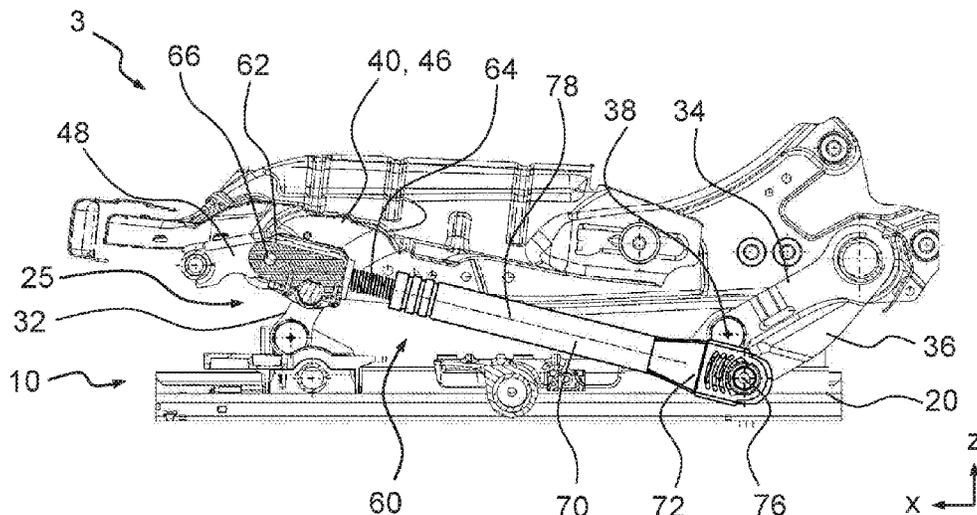
**B60N 2/427** (2006.01)

**B60N 2/06** (2006.01)

**B60N 2/68** (2006.01)

An energy absorber (100) for a vehicle seat (1), in particular for a linear adjuster (60) of the vehicle seat (1), includes a deformation element (110). The deformation element (110) is deformable by forces occurring in a vehicle collision. The energy absorber (100) includes a bending element (120) that releases the deformation element (110). Upon achieving a bending load acting on the bending element (120), the bending element (120) bends and the bending element (120) thereby releases the deformation element (110) to a lesser extent. A linear adjuster (60) for a vehicle seat (1) is also provided, having the energy absorber (100). Further, a vehicle seat (1) is provided having at least such one linear adjuster (60).

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(58) **Field of Classification Search**

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B60N 2/888; B60N 2/42781; B64D  
11/06; B64D 11/0619  
USPC ..... 188/371; 297/216.1  
See application file for complete search history.

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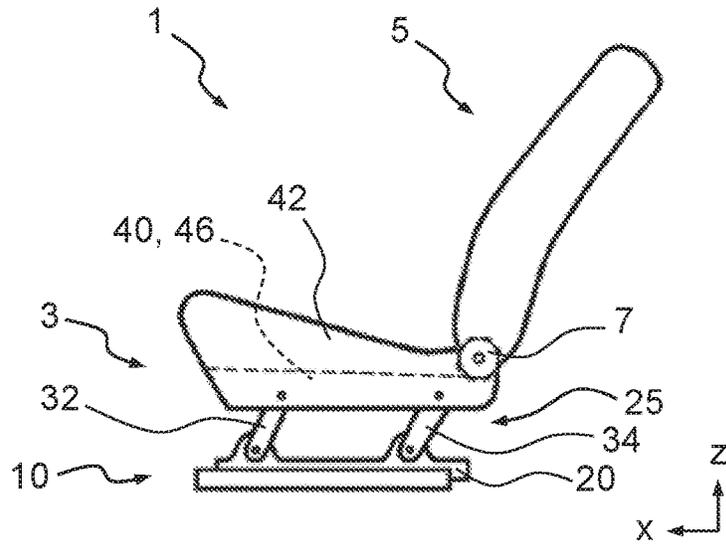


Fig. 1

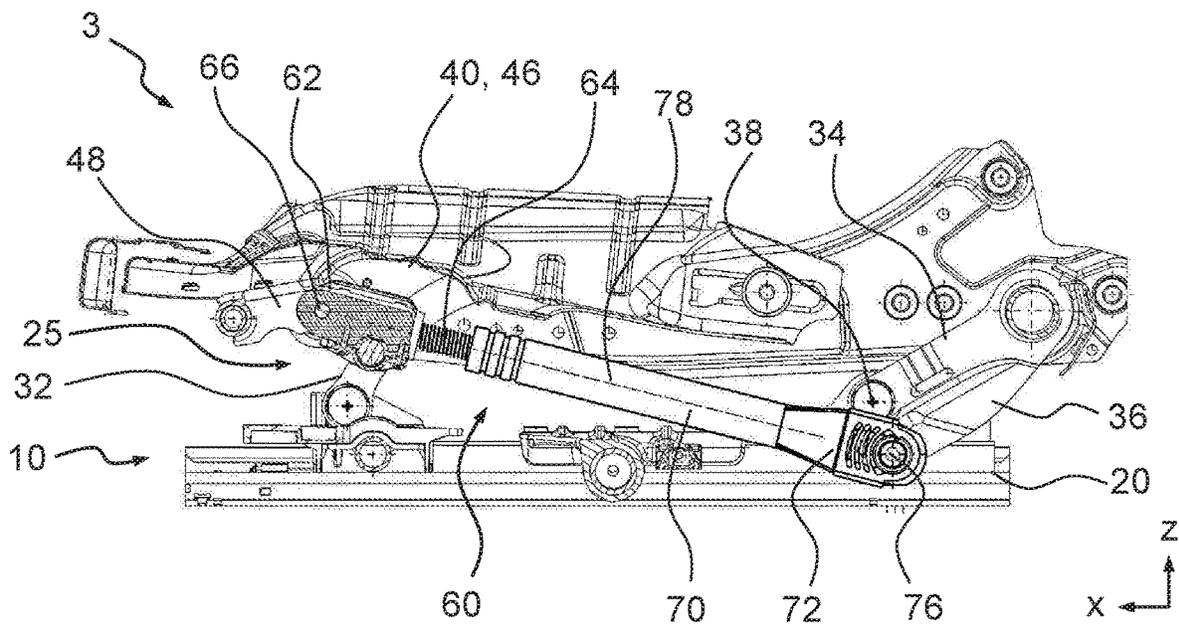


Fig. 2

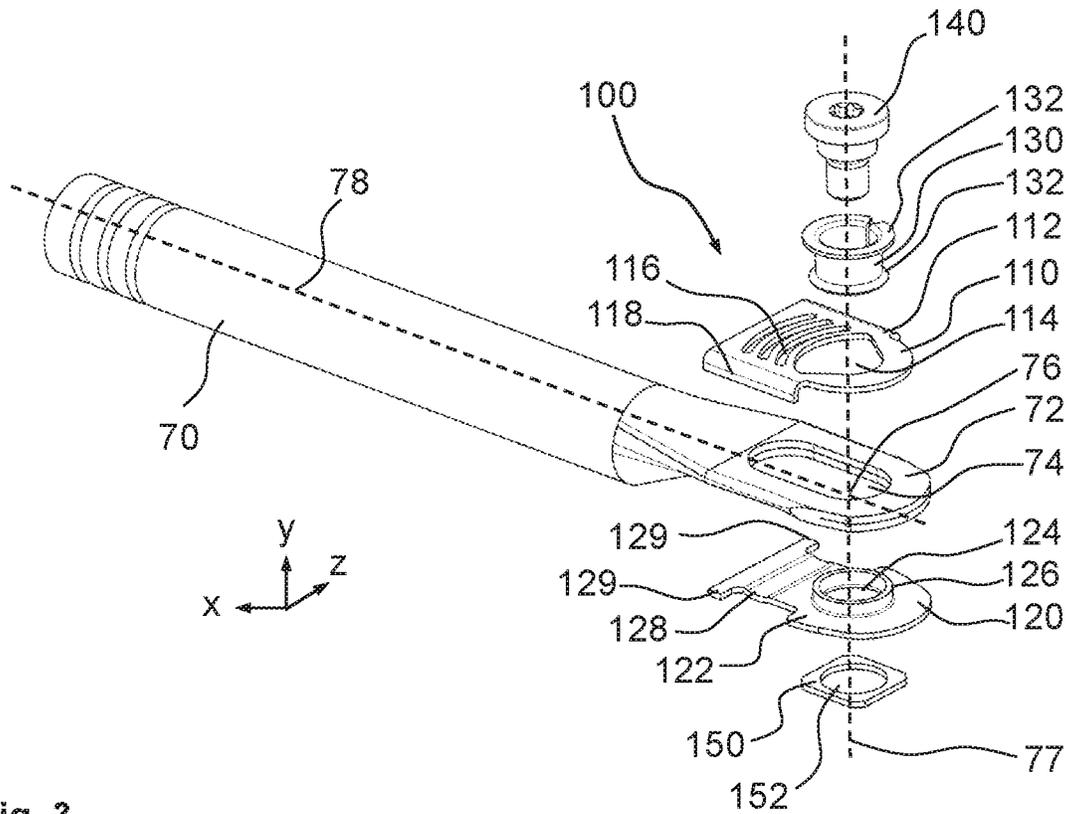


Fig. 3

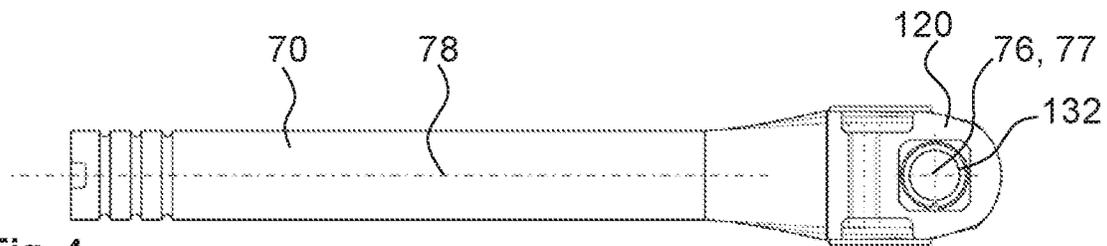


Fig. 4

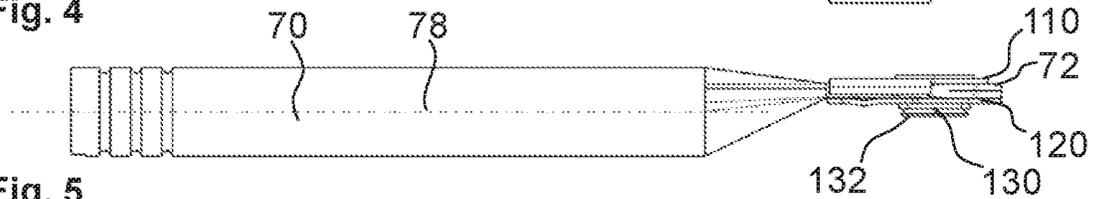


Fig. 5

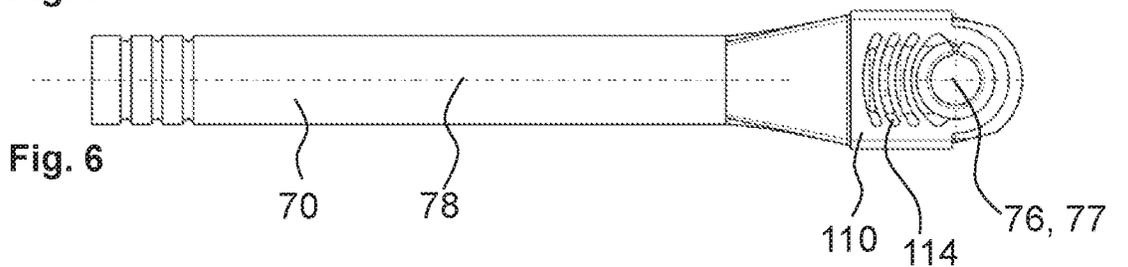


Fig. 6

**ENERGY ABSORBER FOR A VEHICLE  
SEAT, LINEAR ADJUSTER FOR A VEHICLE  
SEAT HAVING AN ENERGY ABSORBER,  
AND VEHICLE SEAT**

CROSS REFERENCE TO RELATED  
APPLICATIONS

This application is a United States National Phase Application of International Application PCT/EP2017/072150, filed Sep. 5, 2017, and claims the benefit of priority under 35 U.S.C. § 119 of German Application 10 2016 217 405.3, filed Sep. 13, 2016, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

The invention relates to an energy absorber for a vehicle seat, in particular for a linear adjuster of the vehicle seat, the energy absorber comprising a deformation element which can be deformed by forces occurring in a vehicle collision. The invention further relates to a linear adjuster for a vehicle seat having such an energy absorber and a vehicle seat.

TECHNICAL BACKGROUND

An energy absorbing device for a vehicle seat is disclosed in DE 198 07 581 A1, said energy absorbing device comprising a separate and removable deformation element which comprises at least one deformation region, wherein the deformation region is capable of being deformed in the event of a collision and thereby absorbing energy.

A vehicle seat having a substantially vertically arranged seat backrest and a substantially horizontally arranged seat surface is disclosed in DE 10 2004 032 785 A1, said vehicle seat having an adjusting device for adjusting the relative position of the seat backrest to the seat surface, wherein the adjusting device comprises a set deformation means which at least partially absorbs the forces occurring in the event of an accident.

DE 10 2010 029 129 A1 discloses a height adjusting device for motor vehicle seats having a control unit which is capable of adjusting and supporting a seat structure relative to a seat floor assembly, which is able to be altered in terms of length and which is able to be connected in an articulated manner at one end to the seat structure and at the other end to the seat floor assembly, wherein the control unit is configured at one end and/or at both ends so as to be mounted relative to the seat structure and/or seat floor assembly by a rotary joint and so as to be displaceable in the event of an impact.

DE 20 2007 006 910 U1 discloses a seat height adjusting device having a seat carrier, a fastening carrier and a pivoting carrier, wherein the pivoting carrier in each case is pivotably articulated to the seat carrier and the fastening carrier, as well as a push element which is movable in a translatory direction and which is coupled to the pivoting carrier via a rotary bearing with a bearing point, wherein the rotary bearing is designed for the displacement of its bearing point in the translatory direction when the action of a critical force is exceeded.

DE 198 07 581 A1 discloses a method for absorbing energy in a motor vehicle seat in the event of a collision, wherein a releasable deformation element is attached in or on the vehicle seat, and the deformation element comprises

at least one deformation region which is capable of being deformed in the event of a collision and thereby absorbing energy.

From the prior art, further energy absorbers in vehicle seats are known from use. The physical principle of the energy absorbers is that, in the event of a vehicle collision, kinetic energy is converted into deformation energy. Typically, energy absorbers are plastically deformed or tear during the vehicle collision. The properties of the components and material are almost fully utilized. In normal operation of the vehicle seat, the energy absorbers are not subjected to any plastic deformation. Only in the case of overloading are the deformation elements deformed or torn and, as a result, the load is reduced on the occupants in order to avoid serious injuries to the occupants.

WO 2010/020567 A1 discloses a subframe of a motor vehicle seat with two rail pairs, two front rockers, two rear rockers and a seat carrier which comprises two side parts, a front crossmember and a rear crossmember, wherein each rail pair is connected in an articulated manner via a front rocker and a rear rocker to a side part, and a linear adjuster configured as a control drive is provided for the height adjustment of the seat carrier, wherein a rocker is connected to a transverse piece and the transverse piece has an articulated region. The articulated region is connected in an articulated manner to one end of a spindle of the control drive.

SUMMARY

An object of the invention is to improve an energy absorber of the type mentioned in the introduction, in particular to be able to adjust in a targeted manner a triggering force of the energy absorber. Additionally, a force path is intended to be adjustable structurally in a targeted manner when the energy absorber is deformed. In particular, an occupant of a vehicle seat which comprises a linear adjuster is designed to be protected from whiplash injury in the event of a rear impact, by energy being dissipated in a targeted manner in a height adjuster comprising a spindle drive. Additionally, a linear adjuster is intended to be provided with an energy absorber according to the invention.

This object is achieved according to the invention by an energy absorber for a vehicle seat, in particular for a linear adjuster of the vehicle seat, the energy absorber comprising a deformation element which can be deformed by forces occurring in a vehicle collision, wherein the energy absorber comprises a bending element which releases the deformation element, wherein, upon achieving a bending load acting on the bending element, the bending element bends and the bending element thereby releases the deformation element to a lesser extent.

As the energy absorber comprises a bending element releasing the deformation element, wherein, upon achieving a bending load acting on the bending element, the bending element bends and the bending element thereby releases the deformation element to a lesser extent, the start of the intended energy conversion may be adjusted structurally in a targeted manner.

“Linear adjuster” is understood as an adjusting component which is articulated, on the one hand, at a first point of articulation to a structural component of the vehicle seat or a further component and, on the other hand, at a second point of articulation to a further structural component of the vehicle seat or a further component, wherein by means of the linear adjuster a spacing between the first point of articulation and the second point of articulation is adjustable,

wherein the two points of articulation move in a substantially linear manner relative to one another. Examples of linear adjusters are seat rails and spindle drives.

“Bending load” is understood as the amount of compressive force acting on the bending element which effects the bending of the bending element. As a result of the bending, the bending element may absorb only compressive forces which are substantially smaller than the bending load.

The deformation element according to the invention may be arranged such that it acts in the pushing direction of the linear adjuster. Alternatively, by a mirrored arrangement the deformation element may be arranged such that it acts in the pulling direction of the linear adjuster. Two deformation elements may be combined together such that a limiting of the load and an energy conversion may take place both in the pushing direction and in the pulling direction of the linear adjuster.

Preferably, in normal operation of the vehicle seat the bending element spans the deformation element. This means that in normal operation of the vehicle seat a force exclusively flows via the bending element, and in the case of a vehicle collision the force only flows via the deformation element chronologically after the bending element has already been bent.

Preferably, the bending element and the deformation element are arranged adjacent to one another. Adjacent to one another means, in particular, adjacent to one another in a transverse direction.

Preferably, the deformation element is deformable only after the bending element has been bent. Before the bending, the deformation element may be outside the flux of force.

For attaching the deformation element, in particular the linear adjuster, to a structural component or a further component of the vehicle seat, a bushing and/or a fastening means may be passed through the bending element and the deformation element.

The bending element preferably has a predetermined bending point. In principle, all of the predetermined bending points of pressure rods known from the prior art are able to be used, in particular recesses, wave-shaped recesses, hole patterns, slots or constrictions.

The deformation element preferably has a base body. Means for the targeted weakening of the base body may be incorporated in the base body, in particular geometries which promote the deformation of the base body. These geometries may be configured as slots, stamped portions, lamellae, recesses or constrictions. A plurality of such geometries arranged in series increase the deformation path and the energy which may be dissipated.

The object is additionally achieved according to the invention by a linear adjuster for a vehicle seat having an energy absorber according to the invention. In this case, the energy absorber may be arranged in a region of a point of articulation of the linear adjuster. A separately configured energy absorber may be provided at both points of articulation of a linear adjuster. Depending on the alignment of the bending element and the deformation element in the linear adjuster, the energy absorber may limit compressive forces or tensile forces. By arranging two opposingly aligned energy absorbers, both tensile forces and compressive forces may be limited. Alternatively, an energy absorber according to the invention may be arranged between a first point of articulation of a linear adjuster and a second point of articulation of a linear adjuster.

The object is additionally achieved according to the invention by a vehicle seat having at least one linear adjuster according to the invention. An occupant of such a vehicle

seat is protected, in particular, against whiplash injury in the event of a rear impact, by energy being dissipated in a targeted manner in the vehicle seat.

In summary and in other words, the invention relates amongst other things to an optimizing of a seat structure, in particular relative to performance relative to whiplash. The invention may be used, for example, in a linear adjuster which is configured as an electrical spindle height adjuster. A height adjuster of a vehicle seat generally comprises a spindle and a spindle nut which is connected to a guide tube. By rotating the spindle the length of the adjustment is altered and, as a result, the seat kinematics attached to both ends is brought into the desired adjusted position. The height adjuster is subjected to tensile forces in the event of a front impact and to compressive forces in the event of a rear impact. In the case of a high compressive load in a rear impact, a fastening means, in particular a screw, covers a defined path by the deformation of a bending element and a deformation element in the direction of an opposing first point of attachment of the linear adjuster to the seat structure. By this targeted deformation, a portion of the impact energy is destroyed by shape alteration and thus the load on the occupant is reduced.

The difficulty of ensuring a targeted deformation is that the deformation may only begin above a defined load threshold. No plastic deformation is able to take place in normal use of the vehicle seat and with the forces produced thereby. When a trigger load threshold is exceeded, the deformation is intended to take place over a defined path and above a level of force which is as consistent as possible. This object has been achieved by, on the one hand, a deformation element being provided for the targeted dissipation of the energy and also a bending element for the targeted introduction of the dissipated energy. After reaching a bending load, the attachment means or a bushing are moved by means of the lamellae of the deformation plate and shape alteration is carried out by the bending of the individual lamellae.

The deformation element preferably has deformable zones and/or individual elements which are successively subjected to load and are deformable and optionally may also become detached. As a result, a long deformation path is possible. By the functional separation of the deformation region in the bending element and the deformation element both the trigger threshold of the energy dissipation and the load level and the path of the deformation may be adjusted structurally.

The deformation element and the bending element may be designed as individual parts with different material thicknesses and strengths or even as a one-piece solution. An essential feature of the invention is the functional separation between the bending and the subsequent deformation.

A high wave as the predetermined bending point on the bending element relative to the material thickness is advantageous relative to the tolerance of the trigger threshold, since production tolerances and assembly tolerances may have less impact in this case. In uniform structures the shaping of the deformation element may be designed for a force level which is as consistent as possible during the deformation. Alternatively, different deformation cross sections which permit a progressive or degressive force path curve are also possible. A reinforcing plate is optionally able to be used when the cross section of the bending element is not sufficient for the operating state, i.e. the bending element is too soft.

The various features of novelty which characterize the invention are pointed out with particularity in the claims

annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

#### BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a schematic side view of a vehicle seat;

FIG. 2 is a side view of a vehicle seat with a four link arrangement as a height adjuster and a control drive with an energy absorber according to the invention;

FIG. 3 is an exploded view of an energy absorber according to the invention;

FIG. 4 is a bottom view of the energy absorber of FIG. 3;

FIG. 5 is a side view of the energy absorber of FIG. 3; and

FIG. 6 is a plan view of the energy absorber of FIG. 3.

#### DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings, a vehicle seat **1** shown schematically in FIG. 1, in particular for a motor vehicle, is described hereinafter by using three spatial directions extending perpendicular to one another. In a vehicle seat **1** installed in a vehicle, a longitudinal direction **x** extends substantially horizontally and preferably parallel to a vehicle longitudinal direction which corresponds to the usual direction of travel of the vehicle. A transverse direction **y** extending perpendicular to the longitudinal direction **x** is also aligned horizontally in the vehicle and extends parallel to a vehicle transverse direction. A vertical direction **z** extends perpendicular to the longitudinal direction **x** and perpendicular to the transverse direction **y**. In a vehicle seat **1** installed in the vehicle, the vertical direction **z** extends parallel to the vehicle vertical axis.

The positional and directional information used, such as for example front, rear, top and bottom refer to a viewing direction of an occupant seated in the vehicle seat **1** in the normal seating position, wherein the vehicle seat **1** is installed in the vehicle in a position of use which is capable of conveying passengers with an upright backrest **5** and oriented in the direction of travel, as is usually the case. The vehicle seat **1** according to the invention, however, may also be installed in a different orientation, for example transversely to the direction of travel.

The vehicle seat **1** has a seat substructure **3** and a backrest **5**. The backrest **5** is connected on both sides by means of one respective fitting **7** to the seat substructure **3**. The seat substructure **3** is able to be fastened by a base **10**, in the present case two rail pairs **20**, to the vehicle floor of the motor vehicle. A height adjusting kinematics **25** of the vehicle seat **1** has in each case on both vehicle seat sides a four link arrangement **25**, often also denoted in the prior art as a quadrilateral linkage. The four link arrangement **25** comprises in each case on both seat sides the base **10**, a front rocker **32**, a rear rocker **34** and a side part **46** of a seat frame **40** which in each case are connected together by means of joints to the four link arrangement **25**.

Apart from the two side parts **46** the seat frame **40** additionally has a front crossmember and a rear crossmember. The two side parts **46**, the front crossmember and the rear crossmember are fixedly connected together to the seat frame **40**, preferably welded thereto. The seat frame **40** additionally bears a seat cushion **42** and in the present case also the backrest **5**. By means of the height adjusting

kinematics **25** the height of the seat cushion **42** and the backrest **5** of the vehicle seat **1** are able to be adjusted above the vehicle floor and thus above the base **10**.

A linear adjuster which is configured as a control drive **60** serves for an electrical adjustment of the height adjusting kinematics **25** and thus an adjustment of the height of the seat cushion **42** above the base **10**.

The control drive **60** is designed as a spindle drive which is driven by means of a gear motor **62**. The control drive **60** is a linear adjuster, the spacing being able to be adjusted thereby between a first point of articulation **66** and a second point of articulation **76**, wherein the two points of articulation **66**, **76** move in a substantially linear manner relative to one another.

The control drive **60** alters its length when the gear motor **62** is actuated. The gear motor **62** is arranged so as to be oriented in parallel with the front crossmember and in the immediate vicinity thereof. The gear motor **62** is connected in an articulated manner to the front crossmember by means of a bearing block **48** in a first point of articulation **66**, in the present case pivotably connected about a first pivot axis parallel to the transverse direction **y**. To this end, two bearing eyes are fastened to the front crossmember. The bearing eyes protrude counter to the longitudinal direction **x** to the rear. The gear motor **62** drives a spindle **64** in an actuated, i.e. switched-on, state in a manner known per se. The spindle **64** is in engagement with a spindle nut which is fixedly inserted in the interior of a drive tube **70**. As a result, this leads to a relative movement between the gear motor **62** and the drive tube **70** when the spindle **64** is rotated by the gear motor **62**. The spindle **64** is screwed into the drive tube **70** or screwed out of the drive tube thereby, depending on the rotational direction. As a result, the control drive **60** alters its length.

The drive tube **70** has a flattened end region **72** remote from the gear motor **62**. In this end region **72**, the drive tube **70** is flattened and configured in a planar manner. The end region **72** has an elongated hole **74** which is oriented parallel to an imaginary connecting line between the first point of articulation **66** and the second point of articulation **76**. The direction of this imaginary connecting line is hereinafter denoted as the effective direction **78**.

One of the two rear rockers **34** is connected to a drive adapter **36**, in the present case welded thereto. The drive adapter **36** is connected in an articulated manner by means of a load limiting device **100**, described in more detail hereinafter, to the end region **72** of the drive tube **70**, so that the drive tube **70** is pivotably connected in the second point of articulation **76** about a second axis of articulation **77** to the drive adapter **36**. The second axis of articulation **77** extends parallel to the transverse direction **y**. The rear rocker **34** which is connected to the drive adapter **36** is connected in an articulated manner in a bearing part to an upper rail of the right-hand rail pair **20**, and namely pivotably about a lower rocker axis **38**. The lower rocker axis **38** extends parallel to the transverse direction **y**. The lower rocker axis **38** and the second axis of articulation **77** are at a distance from one another so that the rear rocker **34** may be driven via the drive adapter **36**. Thus an alteration to the length of the control drive **60** causes the rear rocker **34** to be driven, whereby the height of the vehicle seat **1** is altered.

An energy absorber **100** acting as a load limiter is arranged in the end region **72** of the control drive **60**. The effect of the energy absorber **100** is that a compressive force which is able to be transmitted via the control drive **60** between the first point of articulation **66** and the second point of articulation **76** is limited to a maximum load.

The energy absorber **100** has a deformation element **110**, a bending element **120**, a bushing **130**, a fastening means **140**, which is configured in the present case as a screw, and a reinforcing plate **150**. The components including the bushing **130** and the reinforcing plate **150** are optional and not essential to the invention.

The deformation element **110** is preferably produced from a steel plate but may also be produced from a different deformable material. The deformation element **110** has a planar base body **112** which extends in the effective direction **78** and parallel to the end region **72** of the drive tube **70**. The base body **112** has an opening **114**. A center point of the surface of the opening **114** is arranged approximately in the effective direction **78**. The base body **112** has three slots **116** which in the present case are curved about the second axis of articulation **77**. The three slots **116** form between one another lamellae. The three slots **116** weaken the base body **112** such that it is deformable in a targeted manner. The deformation behavior of the deformation element **110** may be structurally influenced by the shape of the slots **116**, the number of slots **116** and the material and the material thickness of the deformation element **110**. The base body **112** has in each case on both sides extending parallel to the effective direction **78** a limb **118** which protrudes perpendicularly from the base body **112**.

The bending element **120** is preferably produced from a steel plate but may also be produced from a different deformable material. The bending element **120** has a planar base body **122** which extends in the effective direction **78** and parallel to the end region **72** of the drive tube **70**. Viewed in the effective direction **78**, the base body **122** has eccentrically a circular opening **124** which is surrounded by a collar **126**. The collar **126** faces in the direction of the deformation element **110**. A center point of the surface of the opening **124** is arranged approximately in the effective direction **78** and adjacent to the elongated hole **74**. In an outer region of the base body **122** remote from the opening **124** this base body comprises in each case on two opposing edge regions a lug **129** which protrudes approximately perpendicularly from the effective direction **78**, in opposing directions from the base body **122**. A predetermined bending point **128** is arranged between the opening **124** and the lugs **129**. The predetermined bending point **128** in the present case is configured as a recess in the base body **122** of the bending element **120**. The predetermined bending point **128** is a recess with a circular segment-shaped cross section. The predetermined bending point **128** extends perpendicularly to the effective direction **78**. The opening **124** is arranged on one side of the predetermined bending point **128**. The lugs **129** are arranged on the opposing side.

The predetermined bending point **128** is designed such that, upon achieving a bending load acting on the bending element **120**, the bending element **120** bends. According to the principles of engineering mechanics known per se, "bending" is understood in this case as a loss of stability of the bending element **120** with an abrupt deformation of the base body **122** acting as a pressure rod under the action of a compressive force, when the compressive force reaches or exceeds a bending load.

Viewed in the transverse direction y the end region **72** of the drive tube **70** is arranged between the deformation element **110** and the bending element **120**. The openings **114**, **124** of the deformation element **110** and the bending element **120** receive the elongated hole **74** between one another. A circular cylindrical bushing **130** penetrates the openings **114**, **124** of the deformation element **110** and the bending element **120** and the elongated hole **74**. The bushing

**130** has in each case at its two ends a radially outwardly facing flange **132**. One flange **132** bears partially against the base body **112** of the deformation element **110**. The other flange bears against the reinforcing plate **150**, which is positioned on the side of the bending element **120** remote from the end region **72** and has a corresponding through-hole **152** for the bushing **130**. The elongated hole **74** is dimensioned and arranged such that in the direction of the first point of articulation **66** the bushing **130** has freedom of movement inside the elongated hole **74**.

By means of a fastening means **140** which is configured as a screw and which passes through the bushing **130**, the bushing **130** and thus the control drive **60** are attached to the drive adapter **36** of the seat substructure **3**. To this end, the drive adapter **36** has an internal thread, in particular a weld nut.

The two lugs **129** of the bending element **120** are connected to the end region **72** of the drive tube **70**, in the present case welded thereto. Additionally, the two limbs **118** of the deformation element **110** are connected, in the present case welded, to the end region **72** of the drive tube **70**.

When the bending element **120** is bent, the lugs **129** remain fixed relative to the end region **72** due to the connection to the end region **72**, whilst the opening **124** and therewith the bushing **130** are displaced in the direction of the lugs **129**. As a result, the deformation element **110** is deformed by the conversion of kinetic energy into deformation energy.

The features disclosed in the above description, the claims and the drawings may be of significance both individually and also in combination with one another for implementing the invention in the various embodiments thereof.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

The invention claimed is:

1. A linear adjuster for a vehicle seat comprising at least one energy absorber, the at least one energy absorber comprising:

a deformation element deformable by forces occurring in a vehicle collision; and

a bending element which releases the deformation element, wherein, upon achieving a bending load acting on the bending element, the bending element bends and the bending element thereby releases the deformation element to a lesser extent;

wherein the linear adjuster has a first point of articulation and a second point of articulation, wherein the spacing between the first point of articulation and the second point of articulation is adjustable;

wherein the at least one energy absorber comprises one energy absorber that is arranged in a region of the first point of articulation and one further energy absorber that is arranged in a region of the second point of articulation of the linear adjuster.

2. The linear adjuster as claimed in claim 1, wherein the at least one energy absorber is arranged in a region of the first point of articulation or in a region of the second point of articulation of the linear adjuster.

3. A vehicle seat having at least one linear adjuster, the at least one linear adjuster comprising at least one energy absorber, the at least one energy absorber comprising:

a deformation element deformable by forces occurring in a vehicle collision; and

a bending element which releases the deformation element, wherein, upon achieving a bending load acting on the bending element, the bending element bends and the bending element thereby releases the deformation element to a lesser extent; 5

wherein the linear adjuster has a first point of articulation and a second point of articulation, wherein the spacing between the first point of articulation and the second point of articulation is adjustable;

wherein the at least one energy absorber comprises: 10  
one energy absorber arranged in a region of the first point of articulation; and

one further energy absorber arranged in a region of the second point of articulation of the linear adjuster.

4. The vehicle seat as claimed in claim 3, wherein the at 15  
least one energy absorber is arranged in a region of the first point of articulation or in a region of the second point of articulation of the linear adjuster.

5. The vehicle seat as claimed in claim 3, wherein the 20  
bending element has a predetermined bending point comprising a recess in a base body of the bending element.

6. The vehicle seat as claimed in claim 3, wherein the  
deformation element comprises a base body with means for a targeted deformation of the base body comprising a slot.

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